Vacuum-Suspended Shoe

Abstract: Footwear having a vacuum pump for removing fluid from its interior. The footwear can have a rigid outer shell, a flexible material bonded to the rigid outer shell, a thin sheath within the flexible material, a heelstrike-actuated vacuum pump in the heel, and a vacuum hose connecting the vacuum pump to the interior. The pump can be configured to reduce or increase pressure within the footwear to provide different results.
— before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.
VACUUM-SUSPENDED SHOE

BACKGROUND OF THE INVENTION

The present invention relates to an apparatus for suspending footwear, such as a shoe, from the human body by means of vacuum.

SUMMARY OF THE INVENTION

One embodiment of the present invention relates to an apparatus for use on a foot that includes a support portion, a first material within the support portion and enclosing a space in which a foot may be placed, a pump embedded in the heel, and a conduit connecting the pump to the space.

Another embodiment relates to a method for removing fluid from within footwear. The steps of this embodiment can include providing a first material within the interior of the footwear that forms a space into which a foot can be placed and drawing a vacuum against the space after a user’s foot is inserted into the footwear.

Another embodiment of the present invention relates to a method for changing the fluid pressure from within footwear. One step could be to provide a first material within the interior of the footwear. Another step could be to provide a fluid conduit that enables fluid to flow at least one of in and out of the interior. Still another step could be to control fluid flow in or out of the interior through the fluid conduit after a user’s foot is inserted into the footwear to change the fluid pressure within the interior.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a schematic cross-section of one embodiment of the invention in place on the foot.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

In one embodiment the apparatus 10 comprises a support portion such as an outer portions such as a shoe shell 12, with a flexible material 14 therein, wherein the
material 14 is preferably urethane. The flexible material 14 can be bonded to the shoe shell 12. The flexible material 14 can cover the entire foot and provide a air seal at, for example, the patient’s ankle A.

The patient can don a sock 16 or another lining material. Preferably, the sock 16 should not extend above the flexible material 14. The sock 16 can act as an air wick between foot F and the flexible material 14. The sock can absorb, hold, or wick away perspiration.

The apparatus 10 can further include a vacuum pump 18 or other means for reducing pressure. In the preferred embodiment, the vacuum pump 18 is in the heel 20 of the shoe shell 12. A conduit, such as a hose or tube 22, connects the vacuum pump 18 to the inside of the flexible material 14, between the flexible material 14 and the foot F. As the patient walks, the heel-resident vacuum pump 18 is compressed during stance phase and fluid (e.g., air, water vapor, etc.) can be expelled to atmosphere. During the swing phase of walking the heel-resident vacuum pump 18 returns to its normal shape, pulling fluid from between the flexible material 14 and the foot F (and through the sock 16, if one is used), thus creating a vacuum, i.e., lowered pressure, to hold the foot to the inside of the flexible material 14.

The apparatus 10 can further include a one-way valve 24 between the vacuum pump 18 and the hose 22, and a second one-way valve 26 between the vacuum pump 18 and atmosphere. Any suitable one-way valve may be used for the valves 24, 26, such as a duckbill valve or a ball valve with a seat and spring. The valves 24, 26 control the flow of air and substantially stops air from being pumped into the space between the flexible material 14 and the foot F.

Preferably, the shoe shell 12 is composed of a substantially rigid material that stops the shoe shell from collapsing on the foot as vacuum is drawn.

The apparatus may have a mid-dorsal opening 30 with a closure means such as Velcro or shoelaces to allow the patient to don the shoe.
When used to create a lower pressure environment (than ambient) for a foot, the apparatus has application in the removal of moisture (liquid or gas) from the foot or between the foot and shoe. It can also be useful for providing a close fit of a shoe, boot, or the like on the foot, as in downhill ski boots, which could involve the use of conformable shoes, boots, and the like. Still further, the apparatus could also be used to increase or maintain blood flow to the foot, if such flow is desired.

Or, the apparatus could be reconfigured to increase the pressure upon the foot, i.e., to provide a higher pressure environment (than ambient) for a foot. This could be a way of maintaining or reducing fluid volume in the foot. E.g., forcing air between the material 14 and the foot could prevent pooling of fluid in the foot or even drive fluid out of the foot. Preferably, the material 14 would be substantially incompressible or inelastic such that the increased pressure between the material 14 and the foot would result in at least a certain amount of pressure being applied to the foot rather than resulting entirely in the compression or stretching of the material 14. Or, the higher pressure environment could be create outside the material 14, for example, between it and another layer of material 14.

The apparatus could be operated such that pressure is changed, for example, periodically. That is, it could be changed back and forth between higher pressure and neutral (or ambient) pressure, higher pressure and lower pressure, neutral pressure and lower pressure, or some combination of higher, lower, and neutral pressures.

Further, though the apparatus is shown in terms of a shoe configuration, it could also be useful configured as a boot that goes to or above the user's ankle. This boot could include material 14 such that the pressure chamber created therein either ends where shown in Fig. 1 or extends further up the boot.

The present invention may be embodied in other specific forms without departing from the spirit or essential attributes thereof, and it is therefore desired that the present embodiment be considered in all respects as illustrative and not restrictive. For example, components or portions of the apparatus 10 described above could, in
themselves, be provided separately but still provide some or all of the benefits noted above.
WHAT IS CLAIMED:

1. An apparatus for use on a foot, comprising:
   (a) a support portion;
   (b) a first material within the support portion and enclosing a space in which a foot may be placed;
   (c) a pump embedded in the heel; and
   (d) a conduit connecting the pump to the space.

2. The article of claim 1, wherein support portion comprises a shoe shell for surrounding the foot, wherein the first material is flexible and bonded to the shoe shell, and wherein the space is substantially airtight when a foot is inserted therein.

3. The apparatus of claim 1, wherein the apparatus has an exterior appearance of one of a shoe and boot, and wherein the pump comprises a vacuum pump such that actuation of the pump removes fluid adjacent the foot.

4. The apparatus of claim 1, further comprising
   (e) a layer of second material in the space adjacent the first material, wherein the second material is significantly more breathable than the first material.

5. The apparatus of claim 1, further comprising a one-way valve in fluid communication with the pump and the conduit such that fluid will flow substantially only in one direction through the conduit.

6. The apparatus of claim 5, wherein the pump and valve are configured such that fluid flows from adjacent the foot and is released outside the apparatus.

7. The apparatus of claim 5, wherein the pump and valve are configured such that fluid flows into the apparatus.
8. The apparatus of claim 1, wherein the pump is actuated by heelstrike during a user’s stride.

9. The apparatus of claim 1, wherein the support portion comprises an outer shell, and wherein the apparatus further comprises an opening in the outer shell and a fastener for closing the opening.

10. The apparatus of claim 1, wherein the support portion is substantially rigid.

11. The apparatus of claim 1, wherein fluid removed from adjacent the foot by the pump creates a force that holds the apparatus to the foot.

12. The apparatus of claim 1, wherein the apparatus has an external appearance of one of a shoe and a boot.

13. A method for removing fluid from within footwear, the footwear having a heel and an interior, comprising the steps of:

   (a) providing a first material within the interior of the footwear that forms a space into which a foot can be placed;

   (b) drawing a vacuum against the space after a user’s foot is inserted into the footwear.

14. The method of claim 13, further comprising:

   (c) providing a second material adjacent the first material, wherein the second material is significantly more breathable than the first material, and wherein the first and second materials are flexible.

15. The method of claim 13, wherein step (a) comprises bonding the first material to the interior of the footwear and wherein the first material forms a seal with the user’s foot, and wherein step (b) is performed by a heelstrike-actuated vacuum pump within the heel.
16. The method of claim 13, further comprising:
   
   (c) providing a one-way valve in fluid communication with the pump and the conduit such that fluid will substantially flow only in one direction through the conduit.

17. The method of claim 13, wherein the vacuum is sufficient to assist in holding the footwear to the user’s foot.

18. The method of claim 13, further comprising the step of:
   
   (c) discontinuing the drawing of the vacuum and increasing pressure within the space.

19. A method for changing the fluid pressure from within footwear, the footwear having a heel and an interior, comprising the steps of:
   
   (a) providing a first material within the interior of the footwear;
   
   (b) providing a fluid conduit that enables fluid to flow at least one of in and out of the interior;
   
   (c) controlling fluid flow in or out of the interior through the fluid conduit after a user’s foot is inserted into the footwear to change the fluid pressure within the interior.

20. The method of claim 19, wherein the first material provides a seal between the interior and a user’s foot, wherein step (c) comprises forcing fluid out of the interior and substantially preventing fluid flow into the interior.
INTERNATIONAL SEARCH REPORT

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 A43B5/04 A43B7/06 A43B17/03

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED
Minimum documentation searched (classification system followed by classification symbols)
IPC 7 A43B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
EPO-Internal, WPI Data, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

<table>
<thead>
<tr>
<th>Category</th>
<th>Citation of document, with indication, where appropriate, of the relevant passages</th>
<th>Relevant to claim No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>X</td>
<td>US 4 654 986 A (GEORGE FREDERICK W) 7 April 1987 (1987-04-07) the whole document</td>
<td>1-20</td>
</tr>
<tr>
<td>X</td>
<td>US 4 702 022 A (PORCHER PIERRE O) 27 October 1987 (1987-10-27) the whole document</td>
<td>1-3, 5-13, 16-20</td>
</tr>
<tr>
<td>X</td>
<td>DE 199 53 013 A (CHERNYAVSKYI LEONID) 10 May 2001 (2001-05-10) the whole document</td>
<td>1,3, 5-13, 16-20</td>
</tr>
<tr>
<td>X</td>
<td>DE 21 09 422 A (ACHHAMMER JOAHANN) 7 September 1972 (1972-09-07) the whole document</td>
<td>1-3, 5-13, 16-20</td>
</tr>
</tbody>
</table>

Further documents are listed in the continuation of box C. Patent family members are listed in annex.

* Special categories of cited documents:
  **A** document defining the general state of the art which is not considered to be of particular relevance
  **E** earlier document but published on or after the international filing date
  **L** document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reasons (as specified)
  **O** document referring to an oral disclosure, use, exhibition or other means
  **P** document published prior to the international filing date but later than the priority date claimed

** later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
**X** document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
**Y** document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
**S** document member of the same patent family

Date of the actual completion of the international search: 20 April 2004

Date of mailing of the international search report: 27/04/2004

Name and mailing address of the ISA
European Patent Office, P.B. 5818 Patentlaan 2
NL-2280 HV Rijswijk
Tel: (+31-70) 340-2040, Tx: 31 851 epo nl, Fax: (+31-70) 340-3016

Authorized officer: Cianci, S
<table>
<thead>
<tr>
<th>Category</th>
<th>Citation of document, with indication, where appropriate, of the relevant passages</th>
<th>Relevant to claim No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>DE 19 01 606 A (WINTERSBERGER LUTZ)</td>
<td>1-20</td>
</tr>
<tr>
<td></td>
<td>13 August 1970 (1970-08-13)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>page 6, line 32 – page 7, line 26; claims 6,7; figure 5</td>
<td></td>
</tr>
</tbody>
</table>
### INTERNATIONAL SEARCH REPORT

<table>
<thead>
<tr>
<th>Patent document cited in search report</th>
<th>Publication date</th>
<th>Patent family member(s)</th>
<th>Publication date</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>CA 1265333 A1</td>
<td>06-02-1990</td>
</tr>
<tr>
<td></td>
<td></td>
<td>DE 3778923 D1</td>
<td>17-06-1992</td>
</tr>
<tr>
<td></td>
<td></td>
<td>EP 0232163 A2</td>
<td>12-08-1987</td>
</tr>
<tr>
<td></td>
<td></td>
<td>JP 2050666 C</td>
<td>10-05-1996</td>
</tr>
<tr>
<td></td>
<td></td>
<td>JP 7083721 B</td>
<td>13-09-1995</td>
</tr>
<tr>
<td></td>
<td></td>
<td>JP 62249601 A</td>
<td>30-10-1987</td>
</tr>
<tr>
<td></td>
<td></td>
<td>AT 41092 T</td>
<td>15-03-1989</td>
</tr>
<tr>
<td></td>
<td></td>
<td>DE 3662227 D1</td>
<td>13-04-1989</td>
</tr>
<tr>
<td>DE 2109422</td>
<td>07-09-1972</td>
<td>DE 2109422 A1</td>
<td>07-09-1972</td>
</tr>
</tbody>
</table>

Form PCT/ISA/210 (patent family annex) (January 2004)